Space Weather Technical Forecast

Issued on Monday, 31 January 2022 at 00:26 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

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Space Weather Forecast Headline: Chance G2/Moderate Geomagnetic Storm day 2 and 3 (1st and 2nd Feb). Chance of Moderate flares/R1-R2 Radio Blackouts.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity is Low with a number of C-class flares observed originating from the large sunspot group AR2936 (Ehi/Beta-Gamma) near centre of the disc in the northern hemisphere, and also two active regions rotating onto the eastern limb both bi-polar. There are currently three other numbered sunspot regions on the visible disc. AR2934 (Hsx/Alpha) in the southwest remains unchanged. AR2935 (Bxo/Beta) in the northwest has seen some weak growth in its leading spots. AR2938 (Axx/Alpha) in the northeast is unchanged. A coronal mass ejection (CME), is forecast to impact Earth late on day 1 or day 2 (1st or 2nd Feb). This originated from the M-class flare on 29 Jan.

Solar Wind / Geomagnetic Activity: The solar wind, as observed at L1 has been elevated to slightly elevated between 450 and 550 km/s. The density has been at near average levels. The total field strength (IMF) Bt, was mostly weak between 4-6nT. The north-south component, Bz, remained weak and variable ranging between +5nT and -6nT. Phi angle was generally positive (away from the Sun), but has recently become negative (towards the sun). Geomagnetic Activity was Quiet to Unsettled (Kp 1-3).

Energetic Particles / Solar Radiation: The high energy proton flux (greater than 10 MeV) measured at GOES 16 was at background levels. The high energy electron flux (greater than 2MeV), was at background to moderate levels, peaking at 860 pfu at 30/2010 UTC. The associated electron fluence displayed a steadily rising trend and remained below the Active threshold (1e8 integrated flux), with 2.6e7 recorded at 31/0000 UTC.

Four-Day Space Weather Forecast Summary

Solar Activity: Low to Moderate solar activity is expected through the period, with a chance of further isolated M-class flares, and a slight chance of X-class flares. These again most likely from AR2936, and an active region beginning to rotate onto the southeast limb, with a further region emerging onto the northeast horizon.

Solar Wind / Geomagnetic Activity: A CME from 26 Jan could just give a weak Earth-directed glance on day 1 (30 Jan), although confidence is low. Otherwise, slightly elevated solar winds at first on day 1 (30th) are likely to gradually trend downwards towards background through the rest of the period, as the current high speed stream influence wanes. A further slight enhancement is possible from later on day 3 (01 Feb) from coronal hole 48.
Geomagnetic activity is expected to be Quiet to Unsettled (Kp 1-3) with a chance of isolated Active intervals (Kp 4) and a slight chance of G1/Minor Storm (Kp 5) interval on day 1 (30th Jan). Thereafter, becoming generally Quiet to Unsettled, perhaps with a chance of isolated Active intervals from later day 3 (01 Feb). However, pending analysis of the CME from the M1 flare,

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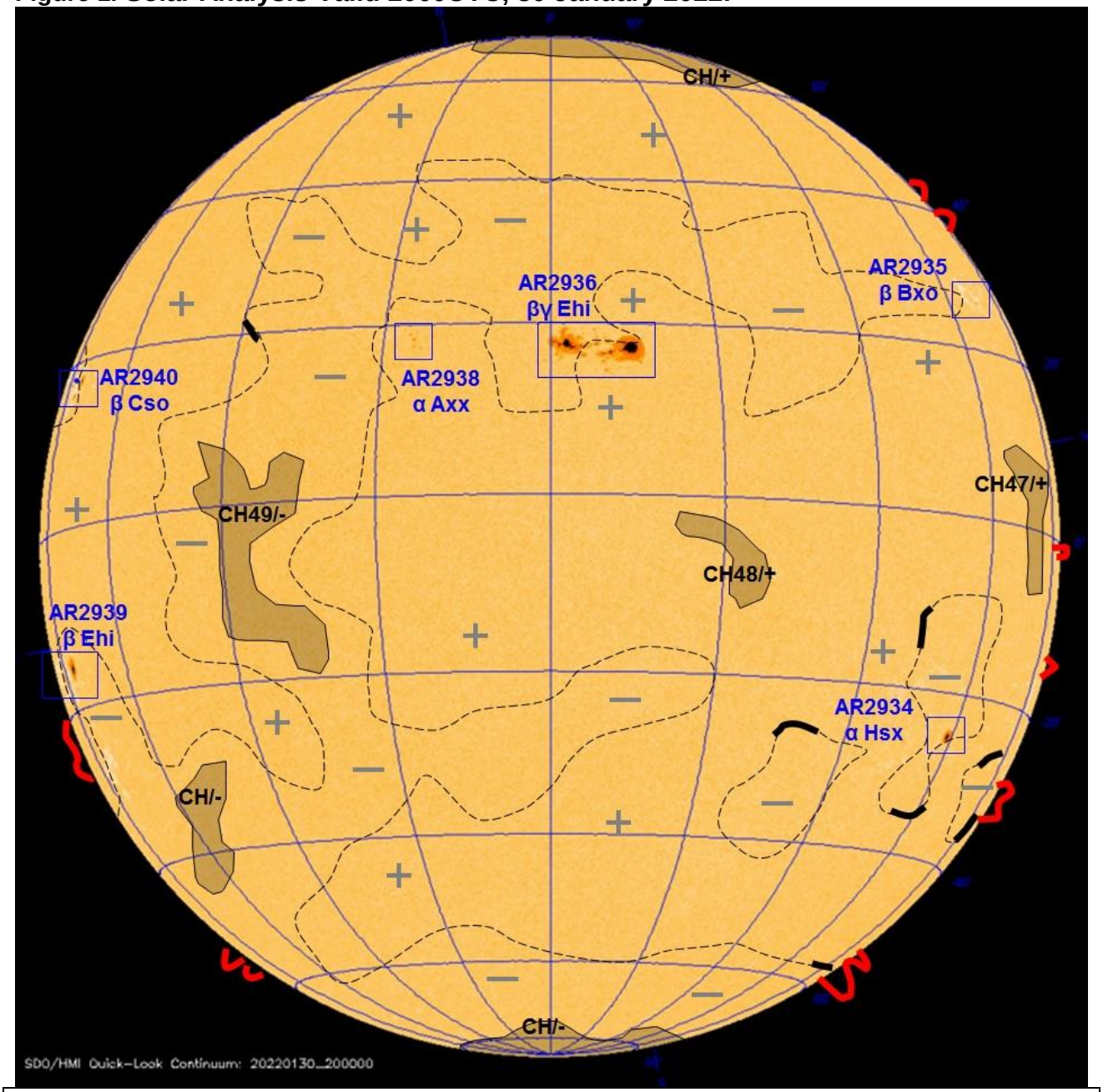
there could be an Earth-directed component, which may result in further enhancement of geomagnetic activity, probably later in the period.

Energetic Particles / Solar Radiation: High energy (greater than 10 MeV) proton flux is forecast to to most likely remain at background levels, however probabilities increase slightly through the period as AR2936 transits west. The high energy electron flux (greater than 2MeV) is expected to remain at predominantly background to moderate levels, but with an increasing chance of high levels being reached at the peak of the diurnal cycles, especially during days 3 and 4 (01 and 02 Feb). The associated 24hr fluence is expected to remain below the Active threshold, despite an increasing trend.

Figure 1. Solar Analysis Valid 2000UTC, 30 January 2022.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms:

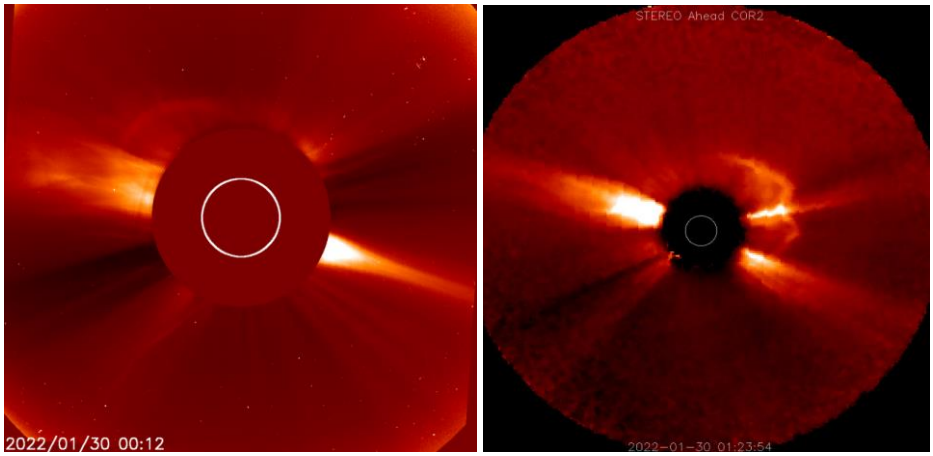
Elevated to slightly elevated solar winds are likely to decline over the next couple of days as the current high speed stream influence from coronal hole 47 wanes. A further enhancement is forecast to arrive from later on day 2 (01 Feb) from coronal hole 48 and the asymmetrical full halo CME from the AR2936 M-class flare that departed the sun on 29 Jan. is predicted to arrive either late on day 2 or during day 3 (1st or 2nd Feb), with a more likely enhancement of solar winds to elevated levels reaching around 550 km/s.
Geomagnetic activity is expected to be Quiet to Unsettled (Kp 1-3) with a chance of isolated Active intervals (Kp 4) and a Chance of G2/Moderate Storm (Kp 6) intervals on day 2 or 3 (1st or 2nd Feb) due to impacts from the CME.

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	5	40	50	20
Strong	G3	No	1	10	20	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections

Date/time 21.5R (UTC)	Halo: Full or Partial	Source	Source Location	Estimated Speed	Estimated Arrival Time	Comments
29/2340	Asymmetrical full halo	AR2936	N09E17	603	01/2300	Limited shock

Figure 2: M1 flare originating from AR2936 produced an asymmetrical full halo CME, which can be seen in available coronagraph imagery (see SDO and STEREO-An images below).



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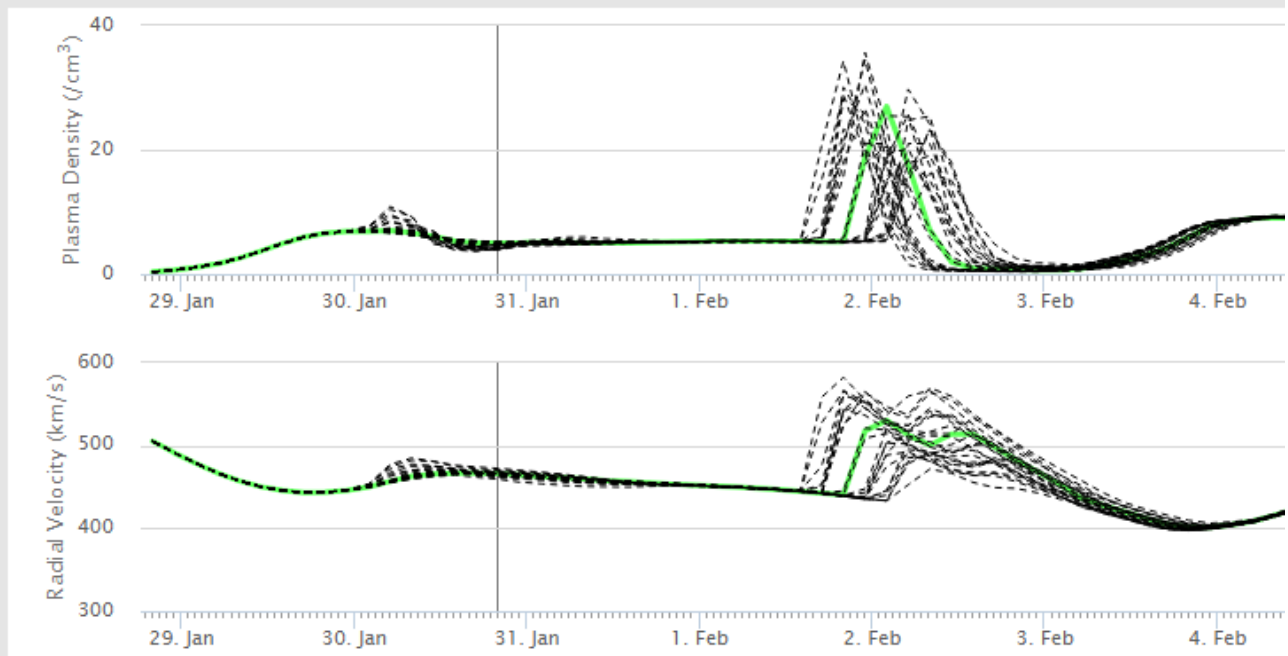
Radio Blackouts - X-Ray Flares:
Solar activity is Low with a number of C-class flares observed originating from the large sunspot group AR2936 (Ehi/Beta-Gamma) near centre of the disc in the northern hemisphere, and also two active regions rotating onto the eastern limb both bi-polar. There are currently three other numbered sunspot regions on the visible disc. AR2934 (Hsx/Alpha) in the southwest remains unchanged. AR2935 (Bxo/Beta) in the northwest has seen some weak growth in its leading spots. AR2938 (Axx/Alpha) in the northeast is unchanged. A coronal mass ejection (CME), is forecast to impact Earth late on day 1 or day 2 (1st or 2nd Feb). This originated from the M-class flare on 29 Jan. Low to Moderate solar activity is expected through the period, with a chance of M-class flares, and a slight chance of X-class flares. Flares are considered to be most likely from AR2936, however there are currently signs of flux emergence in the trailing spots of both the newly emerging regions now rotating onto the visible disc, AR2939 and AR2940 and both of these two regions may well become more active in the days to come.

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	No	50	50	40	40
Very Active	R3 to R5 X Class	No	10	10	10	10

Figure 3: Met Office ENLIL ensemble product indicating range of times for CME Earth impact around 01/2300UTC.



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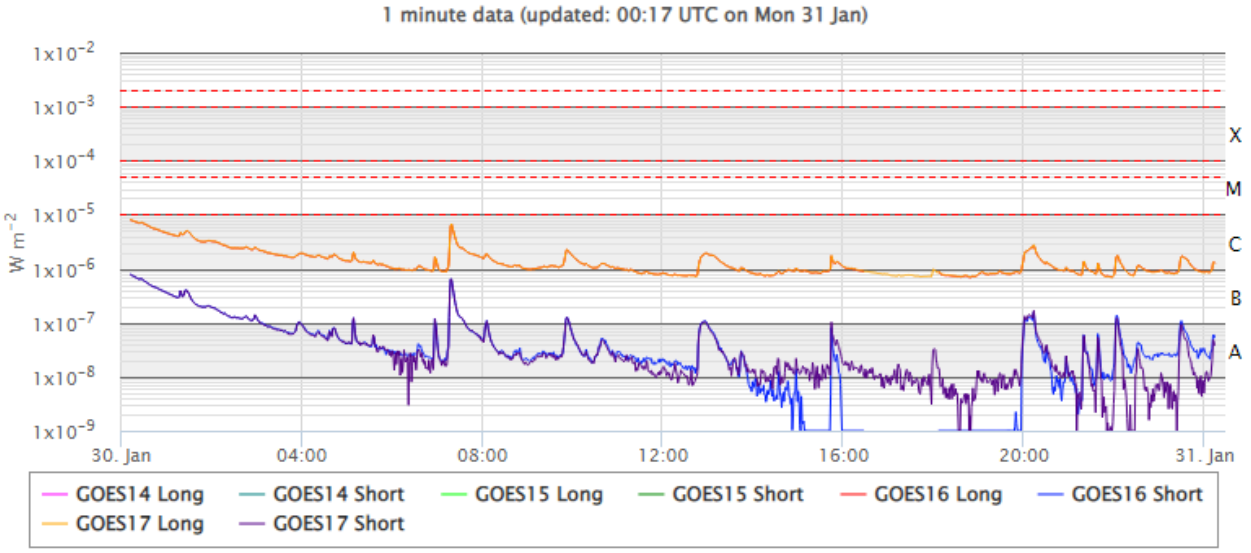
Solar Radiation Storms - (High Energy Protons):

The high energy proton flux, as measured by GOES-16 is at background levels. No solar radiation storms are likely in the period, however probabilities increase through the period as AR2936 transits westwards towards the limb.

Radiation Storms Probability (Exceedance)	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	No	5	5	10	10
Very Active	**≥ S3 ***	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

Figure 4: GOES X-Ray Flux plot showing a number of C-class flares observed over the past 24 hour period.



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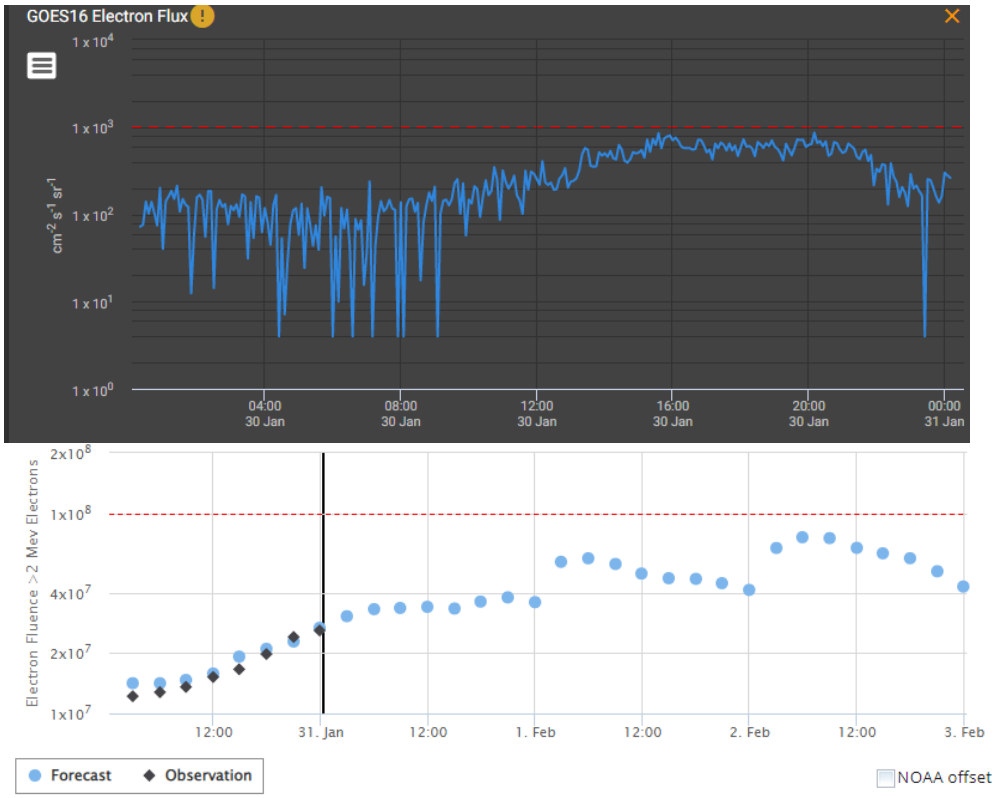
High Energy Electrons Event (≥ 2MeV):

The high energy electron flux (greater than 2MeV) as observed by GOES-16 at GEO, was at background to moderate levels, peaking at 860 pfu at 30/2010 UTC. The high energy electron flux is expected to remain at predominantly background to moderate levels, but with an increasing chance of high levels being reached at the peak of the diurnal cycles, especially towards the end of the four day period. However the incoming CME from the M1 flare originating from AR2936, will likely impact the high energy electron forecast, with a temporary reduction in probability on day 3 (2 Feb).

With only a limited flux response anticipated from either fast wind enhancement, the associated 24hr fluence is expected to remain below the Active (1e8 integrated pfu) level despite an increasing trend. The Met Office REFM output supports fluence levels remaining below the Active period, and this is considered to be good guidance at this stage, although confidence reduces to low by day 4 (3 Feb).

GEO Electron Environment Probability (Exceedance)	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ 2 MeV ≥ $1x10^8$**	No	20	30	20	40
Very Active	**≥ 2 MeV ≥ $1x10^9$**	No	1	1	1	1

Figure 5: High energy electron flux plot at GEO and Met Office REFM electron fluence observations and forecast – trending upwards through the period.



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